Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

B. Tech. ETRX

B. Tech. (Electronics Engineering)

Syllabus

(Semester V-VI)

2020 Iteration (w.e.f. 2021-22)

B. Tech. ETRX

2020 ITERATION: ELECTRONICS DOMAIN

Nomenclature of the Courses

BSC	Basic Science Course	**PC**	Program Core
BSE	Basic Science Elective	**PE**	Program Elective
ESC	Engineering Science Course	**MLC**	Mandatory Learning Course
ESE	Engineering Science Elective	**SCOPE**	Skill Certification for Outcome based Professional Education
SBC	Skilled Based Course	**OE**	Open Elective
ABL-SATVA	Self- Accomplishment Through Various Activities	**HSSE**	Humanities and Social Science Elective
ABL-SEVA	Social Empowerment Through Various Activities		

Abbreviations

L	Lecture Hour	**O**	Other Work (Self Study)
T	Tutorial Hour	**E**	Total Engagement in Hours
P	Laboratory Hour	**C**	Credit Assigned

Semester V									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	PC	ET301	Analog and Digital Communication	3	0	2	6	11	4
2	PC	ET302	Control Systems	3	0	2	6	11	4
3	PC	ET303	Digital Signal Processing	3	0	2	5	10	4
4	PC	ET304	Electromagnetic Waves	3	0	2	5	10	4
5	SBC	ET305	Java Programming Lab	0	1	2	2	05	2
6	ABL	SVXX/STXX	SEVA II or III /SATVA II or III	0	0	0	2	02	1
7	HSSE	HSEX3	HSS-III	2	0	0	3	05	2
8	S/M	SCX2/MNX2	SCOPE-II/Minor-II						3
TOTAL									**21**

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Semester VI									
Cat 1- For Students who have NOT preferred semester long internship									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	OE	OEXXX	Open Elective-I	2	--	2	3	7	3
2	PC	ET306	Power Electronics	3	--	2	06	11	4
3	PC	ET307	Computer Communication Networks	3	--	2	06	11	4
4	PE	ET3X1	PE-I	3	--	--	5	8	3
5	PE	ET3X2	PE-II	3	--	--	5	8	3
6	SBC	ET308	Mini Project-II	-	-	-	-	-	3
7	ABL	SVXX/STXX	SEVA II or III /SATVA II or III	-	-	-	02	02	1
8	S/M	SCX3/MNX3	SCOPE-III/Minor-III	-	-	-	-	-	3
TOTAL									**21**

Semester-VI									
Sem VI (Cat 2-For Students who have preferred semester long internship)									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	PE*	ET3X1	PE-I	--	--	--	--	--	3
2	PE*	ET3X2	PE-I	--	--	--	--	--	3
3	SBC	ET310	Industry Internship	--	--	--	--	--	15
4	S/M*	SCXX/MNXX	SCOPE-III/Minor-III	--	--	--	--	--	3
***To be completed online mode or allied courses from MOOCs (minimum 08-12 weeks)**							**TOTAL**		**21**

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PE/TD	PE1	PE2	PE3	PE4	PE5	PE6
THREAD 1: VLSI & Embedded Systems	1T11: Digital CMOS VLSI Design	1T12: Embedded Systems	1T13: Real Time Operating Systems	1T14: Analog CMOS VLSI Design	1T11, 1T12, 1T21, 1T22, 1X, 1Y, 1P, 1Q 2T11, 2T12, 2T21, 2T22, 2X, 2Y, 2P, 2Q (1T25 * Networking Fundamentals)	1T11, 1T12, 1T21, 1T22, 1X, 1Y, 1P, 1Q 2T11, 2T12, 2T21, 2T22, 2X, 2Y, 2P, 2Q (1T25 * Networking Fundamentals)
THREAD 2: Signal Processing	1T21: Speech and Audio Processing	1T22: DSP Processors	1T23: Image and Video Processing	1T24: Principles Soft Computing		
THREAD 3: Power Electronics and Energy Systems	1X: Power Electronic Converters *	1Y: Embedded System Design for Power Converter Applications	1P: Energy Storage Systems in EV Applications	1Q: Power Electronic Converters in EV Applications		
	1T11,1T12, 1T21,1T22, 1X,1Y, 1T25 * 2T11, 2T12, 2T21, 2T22, 2X, 2Y	1T11,1T12, 1T21,1T22, 1X,1Y, 1T25 * 2T11, 2T12, 2T21, 2T22, 2X, 2Y	1T13, 1T14, 1T23, 1T24 1P,1Q, 2T13, 2T23, 2T23, 2T24, 2P, 2Q	1T13, 1T14, 1T23, 1T24 1P,1Q, 2T13, 2T23, 2T23, 2T24, 2P, 2Q		

(* 1X, 1T25 are available only for Category 2 students)

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Semester-V

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Analog and Digital Communication	3	0	2	5	10	3	0	1	4
		Examination Scheme								
ET301		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC202: Electronic Devices MA203: Probability and Stochastic Processes EC207: Signals and Systems
Course Objective: The objective is to equip the students with basic knowledge for analyzing analog and digital communication systems ranging from data networks and internet to mobile data communication systems such as cellular and WiFi systems. Specifically, the students will learn how to manage communication system resources including bandwidth and power by selecting a proper signaling and/or analog/pulse/digital modulation scheme	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET301.1	Describe various entities of analog, pulse, and digital communication system.
ET301.2	Apply concepts of signals and systems to analyze behavior of modulated signals in time domain, frequency domain and signal space.
ET301.3	Analyze and compute system performance measures such as efficiency, bit rate and bandwidth of various analog, pulsed and digital modulation methods.
ET301.4	Analyze the behavior of a various analog, pulse, and digital modulation schemes in presence of noise.
ET301.5	Compare various modulation and demodulation techniques.
ET301.6	Examine various wired and wireless applications and further infer health, safety, and environment aspects of wired and wireless systems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET301.1	3				-				-	-		1
ET301.2	2	2			3				3	3		
ET301.3	2	2			3				3	3		1
ET301.4	3	3			3				3	3		1
ET301.5	2	2			3				3	3		
ET301.6	1	1				1	1	1	3	3		3

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CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET301.1	2	2				
ET301.2	2	2		2	1	
ET301.3	2	2		2	2	
ET301.4	2	2		2	2	
ET301.5	2	2				
ET301.6	1	1				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	Understand ·	Apply ·	Analyze ·	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Continuous-Wave Modulation**	1,2	**10**
	1.1	Review of signals and systems, Frequency domain representation of signals, classification of Frequency spectrum, Block diagram of an analog and digital communication system, Need for modulation.		
	1.2	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations, Principle of FDM.		
	1.3	Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.		
	1.4	Super heterodyne receiver		
	1.5	Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.		
2	Title	**Pulse Modulation**	1,2	**08**
	2.1	Sampling process. Types of Pulse modulation		
	2.2	Pulse code modulation (PCM), Differential pulse code modulation.		
	2.3	Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers		
3	Title	**Baseband Pulse Transmission**	1,2	**10**
	3.1	Baseband receiver, Probability of error of integrate and dump receiver, Matched filter, optimum filter		

	3.2	Line coding and Power spectral density (PSD) of line codes, inter symbol Interference and Nyquist criterion, Raised cosine filter,		
	3.3	Duobinary encoding, Introduction to linear and adaptive equalization		
4	**Title**	**Pass band Digital Modulation schemes**	2	**14**
	4.1	BPSK, DPSK, QPSK, M-ary PSK, QAM, BFSK, M-ary FSK, MSK- Principle of working, PSD, and Signal space analysis		
	4.2	Digital Modulation tradeoffs, Probability of Error evaluations of various modulations. (Derivation not expected)		
	4.3	Synchronization and Carrier Recovery for Digital modulation.		
	4.4	Introduction to OFDM		
5	**Self-Study**	**a. Case study (any one)** 1. Effect of various Communication systems on health, safety, and environment. 2. Professional engineering regulations, legislation and standards related to communication. 3. Code of ethics for wired and wireless systems for user/devices/companies **b. Research article (any one)** 1.Applications of analog and digital modulations 2.Digital modulations specifications and effect of various parameters in wireless networks such as WLAN 3.Software defined radio for digital communication 4. Error correction codes for digital communication 5.Comparative analysis of analog and digital communication through applications		**06**
			Total	**42+6**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	**Title of the Experiment**
1	Simulation and implementation of double sideband full carrier for various modulation index.
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Analyze effect of pre-emphasis and de-emphasis on FM waveforms.
4	Implementation of natural sampling and reconstruction of waveforms
5	Implementation and detection of pulse amplitude modulation.
6	Implementation of Binary Phase Shift Keying.
7	Implementation of Binary Frequency shift keying.
8	Duo binary Encoder.

9	Simulation of digital modulation scheme and analysis of Power spectral density.
10	Simulation and analysis of signal space of various modulations in presence of noise.
11	Signal transmission through Raised cosine filter and eye pattern analysis.
12	Simulation of OFDM.
13	Mini project in analog/pulse/digital modulation methods.

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Communications Systems	Fourth	Haykin S	John Wiley and Sons	2001
2	Principles of Communication Systems	Second	Taub H. and Schilling D. L	Tata McGraw Hill	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication.	Third	Haykin S	John Wiley and Sons	2001
2.	Communication Systems Engineering	Fourth	Proakis J. G. and Salehi M.	Pearson Education	2002
3.	Digital and Analog Communication	Fourth	B.P.Lathi	Oxford	2017

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Control Systems	3	0	2	6	11	3	0	1	4
ET302		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis EC 101: Digital Systems and Microprocessors EC 203: Probability and Stochastic Processes EC 204: Electronic Instruments and Measurement Lab
Course Objectives: To develop a system for real life application by applying the concepts of control system theory and allied techniques for system performance evaluation.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET302.1	Classify different types of control systems, component of control system and formulate mathematical modeling of the given system.
ET302.2	Apply various methods for representation of the given control system.
ET302.3	Analyze the transient and steady state behavior of given system for standard test inputs.
ET302.4	Analyze the stability of systems in time domain and frequency domain.
ET302.5	Discuss the concept of controllability and observability using state variable model.
ET302.6	Evaluate the system performance with the use of compensators & controllers.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET302.1	3				2			3	3	2	2	2
ET302.2		3			2			3	3	2	2	2
ET302.3		3			2			3	3	2	2	2
ET302.4		3			2			3	3	2	2	2
ET302.5		3			2			3	3	2	2	2
ET302.6	3				2	2		3	3	2	2	2

***Separate tables are added CO-PEO/PSO Correlation Matrix since PSOs for ETRX and EXTC Department are different.**

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CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET302.1	1	1	2		--	
ET302.2	1	1	2		--	
ET302.3	1	1	2		2	
ET302.4	1	1	2		2	
ET302.5	1	1	2		2	
ET302.6	1	1	2		2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ·	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to control system and system Modeling**		10
	1.1	**Introduction to control system:** Definition of system, Notion of feedback, Open loop and closed loop systems; feedback and feed forward control structure; Examples of control systems.	1,2	
	1.2	**Dynamic Response:** Standard test signals; Transient and steady state behavior of first and second order systems; Generalized error coefficients, steady state errors in feedback control systems and their types.	1,2	
	1.3	**Control System Modeling:** Types of model's Impulse response model, State variable model, Transfer function model, Modeling of electrical systems and translational mechanical systems.	1,2	
2	Title	**Representation of Control System and State Space Analysis**		10
	2.1	Block diagram representation of systems, Block diagram reduction methods, closed loop transfer function, signal flow graph. Mason's gain rule	1,2	
	2.2	**State Space Analysis:** Concepts of state space, State equations, State transition matrix, properties of state transition matrix, Solution of homogeneous systems.	1,2	
	2.3	**Controllability and Observability:** Concept of controllability, Controllability analysis of LTI systems, Concept of observability, Observability analysis of LTI systems using Kalman approach.	3,4	
3	Title	**Time Domain System Stability Analysis**		8

	3.1	Concepts of Stability Concept of absolute, relative and robust stability	1,2	
	3.2	Routh-Hurwitz stability criteria	1,2	
	3.3	**Root Locus Analysis:** Root-locus concepts; General rules for constructing root-locus, Root-locus analysis of control systems.	1,2	
4	**Title**	**Frequency Domain System Stability Analysis**		**8**
	4.1	Relation between time and frequency response	1,2	
	4.2	**Bode Plot:** Magnitude and phase plot, Method of plotting Bode plot; Stability analysis by using Gain and phase margins on the Bode plots	1,2	
	4.3	Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	1,2	
5	**Title**	**Compensators & Controllers**		**6**
	5.1	Types of compensators, Realization of basic compensators – cascade compensation in time domain and frequency domain.	1,2	
	5.2	**Controllers**: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	1,2	
	5.3	**Advanced Control Systems:** Introduction to Robust Control, Adaptive control and Model predictive control, Neuro- fuzzy controllers.	3,4	
6	**Self-Study**	Examples on open loop and closed loop control system, Modeling of rotational mechanical systems, Pole placement using state feedback Popov–Belevitch–Hautus (PBH) test in state space, Design of lag, lead and lag-lead compensator using Bode plot and Root locus techniques, Design of real-life applications of control system.	1,2,3, 4,5	
			Total	**42**

Laboratory Component:

Exp. No.	Experiment Details	Marks CO
1	To obtain the characteristics of control system components: i. To plot the Synchro transmitter characteristics and Synchro transmitter and receiver as an error detector. ii. To plot characteristics of Potentiometer and its loading effect for different conditions of load.	05 CO1
2	To demonstrate the working of real-life feedback control system and obtain their characteristics: i. To plot Speed torque characteristic of DC servo motor. ii. To determine the line and load regulation characteristics of AC servo voltage stabilizer at different line and load conditions and observe the mechanism of AC voltage stabilization as an example of closed control system.	05 CO1
3	To develop a program in Matlab/Scilab/LabVIEW:	05

	i. To define the given closed loop transfer function of system and plot their poles & zeros on s-plane. ii. To reduce the given control system block diagram or signal flow graph.	CO2
4	To develop a program in Matlab/Scilab/LabVIEW: i. To obtain the step response of a given first/second order control system and obtain its time domain parameters from this step response. Compare these results with mathematical calculations. ii. To determine step response for a Type 0, Type 1, Type 2 systems and find error coefficients. iii. To find solution for a given control system described by its state space equation in terms of state transition matrix, zero input response, zero state response, complete response.	10 CO3
5	Develop a program in Matlab/Scilab/LabVIEW: i. To obtain the root locus of a system described by its Transfer Function with unity feedback, Comment on the stability of this given control system. Compare these results with mathematical calculations. ii. To find gain margin and phase margin of the system described by its Transfer Function with unity feedback using Bode/Nyquist plot. Comment on the stability of this given control system. Compare these results with mathematical calculations.	10 CO4
6	Develop a program in Matlab/Scilab/LabVIEW: i. To find whether a given control system described by its state space equation is controllable or not, observable or not, to find rank of matrix and using rank comment on system controllability and observability. ii. To design a controller and observer via state space.	10 CO5
7	Evaluate the effect of Compensator/PID controller on performance of the control system.	5 CO6

ISE Evaluation: CO1-CO6

Mini-Project: Identify the model of control system for real life application and demonstrate controlling action for the same.

This is group activity. Students will form a group of minimum 3 students. Students will develop the block diagram of the system first, then design each block using appropriate components. Simulate the complete block diagram using any tool like Matlab, Scilab or LabVIEW. The duration of this activity is a complete semester, but evaluation will be done in phases and rubrics designed. In the first phase students will develop the block diagram for the given problem statement. In the second phase students will develop the block diagram and simulate each of the block diagrams and test it for input-output relationship. In the third phase students will interface all the designed blocks to obtain final input-output relationship of the system. Hardware implementation is optional.

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Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems Engineering	Fifth	I. J. Nagrath, M. Gopal	New Age International	2012
2	Modern Control Engineering	Fifth	Ogata. K	Prentice Hall of India	2010

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems: Principle and design	First	M. Gopal	Tata McGraw Hill	1998
2	Modern Control System	Eleventh	Richard C. Dorf and Robert H. Bishop	Pearson	2013
3	Control Systems Engineering	Sixth	Norman Nise	John Wiley & Sons	2011
4	Linear Control System Analysis and Design: Conventional and Modern	First	Constantine H. Houpis and John J. D'Azzo	Mcgraw-Hill	1975

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Digital Signal Processing	3	0	2	5	10	3	0	1	4
ET303		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC207: Signals and Systems
Course Objective: To develop mathematical foundation of system and design digital filters	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET303.1	Classify and perform various operations on signals and systems.
ET303.2	Apply DFT properties and illustrate FFT algorithms.
ET303.3	Apply Z Transform on discrete time signals.
ET303.4	Analyze LTI System using Z Transform.
ET303.5	Design and Realize Digital filters.
ET303.6	Analyze Multirate Signal Processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET303.1	3	1	2		2							
ET303.2	1	1	2		2							
ET303.3	1	1	2		2							
ET303.4	1	1	2		2							
ET303.5	1	1	2		2							
ET303.6	1	1	2		2							2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET303.1		2				2	
ET303.2		2				2	
ET303.3		2				2	
ET303.4		2				2	
ET303.5		2				2	
ET303.6		1				2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

B. Tech. ETRX

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Overview of Discrete Time Signals**	6,7,8	08
	1.1	Sampling of Continuous Time Signal, Standard Discrete Time Signals: Impulse Signal, Unit Step, Unit Ramp, Sinusoidal, Exponential.		
	1.2	**Classification of Signals:** Deterministic and non-deterministic, Periodic and a periodic, Symmetric (even) and Asymmetric (odd), Energy and Power, Causal and Anti-causal signals.		
	1.3	**Operations of Signals:** Shifting, Scaling, Time Reversal, Addition and Multiplication, Convolution (Linear and Circular), Correlation		
2	Title	**Discrete Fourier Transform (DFT)**	1, 3	12
	2.1	Discrete Time Fourier transform (DTFT), Discrete Fourier Transform (DFT), Properties of DFT, Inverse DFT.		
	2.2	**Fast Fourier Transform:** Radix-2 Decimation in Time Fast Fourier Transform (DIT-FFT) and Decimation in Frequency Fast Fourier Transform (DIF-FFT) algorithms, Real and Complex Calculations using FFT, Linear and Circular Convolution using FFT,		
	2.3	Filtering of long data sequence, Overlap Add Method, Overlap Save Method		
3	Title	**Z-Transform**	6,7	04
	3.1	Z-Transform of discrete time signals, Properties of Z-Transform, Relation between Z-Transform and DTFT,		
	3.2	Inverse Z-Transform, Long division Method, Partial Fraction Expansion Method		
4	Title	**Linear Time Invariant (LTI) Systems**	1,4	08
	4.1	**Classification of systems:** Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems.		
	4.2	Impulse Response, Transfer Function, Differential Equation, Stability of Systems, Frequency Response, Solution of Differential Equation using Z-Transform		
	4.3	LTI systems as frequency-selective filters like; Low pass, High pass, Band pass, Invertibility of LTI systems, Minimum-phase, Maximum-phase, Mixed-phase systems		
5	Title	**Design of Digital filters and Implementation**	1,2	10
	5.1	Design of Infinite Impulse Response (IIR) filters using Impulse Invariant Method and Bilinear Transformation Method, Butterworth and Chebyshev Type I filter design.		

	5.2	Concepts of Finite Impulse Response (FIR) filter, symmetric and anti-symmetric FIR filter, FIR filter design using Window method and Frequency sampling method.		
	5.3	Realization structures for IIR and FIR filters using direct Form Realization, cascade, parallel structures; Linear Phase Realization, Frequency Sampling Realization.		
6	**Self-Study**	**1.Multirate Signal Processing:** Down-sampling and Up-sampling by integer factors; Decimator and Interpolator, Sampling rate conversion by non-integer factor. 2. **Application of Filter**: Sub-band filters.	1,5	***5**
			Total	**42+*5**

Laboratory Component

Sr. No	Title of the Experiment
1	Discrete Convolution and Correlation
2	Discrete Fourier Transform
3	Fast Fourier Transform
4	Linear Filtering using Overlap Add Method/ Overlap Save Method.
5	Design of Butterworth IIR Filter using Impulse invariant method
6	Design of Butterworth IIR Filter using Bilinear Transformation method
7	Linear phase FIR Filter design using Windowing method
8	Linear phase FIR Filter design using Frequency sampling method
9	Multirate Signal Processing
10	Mini Project on real Time DTSP application

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing: Principles, Algorithms and Applications	Fourth	J. Proakis, D. G. Manolakis, and D. Sharma	Pearson Education	**2014**
2	Digital Signal Processing	Fourth	Ramesh Babu	Scitech	2014
3	Digital Signal Processing	-	S.Salivahanan, A Vallavaraj, C Gnanapriya	Tata McGraw Hill	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Signals and Systems	Second	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab	Pearson	2002
2	Signals and Systems	Third	Simon Haykin and Barry Van Veen	John Wiley & Sons	2002

3	Theory and Applications of Digital Signal Processing	Second	L. R. Rabiner and B. Gold	Prentice-Hall	2006
4	Multirate Systems and Filter Banks	First	P.P. Vaidyanathan,	Pearson	1992

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Electromagnetic Engineering	3	0	2	6	11	3	0	1	4
ET304		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis MA201: Linear Algebra
Course Objective: To teach fundamentals of Electromagnetic Waves	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET304.1	Apply basic laws of electromagnetic and Maxwell's equations.
ET304.2	Illustrate the behavior of EM waves and travelling of waves in free space as well as media.
ET304.3	Solve problems related to the propagation of electromagnetic waves.
ET304.4	Discuss the types of antennas and their parameters.
ET304.5	Discuss types of radio wave propagation.
ET304.6	Design applications using Electromagnetic Waves theory.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET304.1	1	1	2		2					3		
ET304.2	1	1	2		2							
ET304.3	1	1	2		2					3		
ET304.4	1	1	3		2					1		
ET304.5	1	1	2		2							
ET304.6	1	1	3		2					2		3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET304.1		2			2	
ET304.2		2			2	
ET304.3		2			2	
ET304.4		2			2	
ET304.5		2			2	
ET304.6		1			1	

B. Tech. ETRX

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Coordinate system transformation and vector calculus**		3
	1.1	Cartesian, cylindrical and spherical coordinate, Differential length, area and volume, line surface and volume integrals.	2	
	1.2	Del Operator, Gradient of scalar, Divergence of a vector and Divergence Theorem, Curl of a Vector and Stoke's Theorem, Laplacian Theorem, Classification of a Vector Field.		
2	Title	**Basic Laws of Electromagnetic and Maxwells Equations**	1	9
	2.1	Coulombs law, Electric fields due to continuous charge distributions, Gauss law and its applications, Electric potential (Magnetic vector potential and Electrical Scalar Potential), relationship between E and V, Poisson and Laplace equations, Bio-Savarts law, Amperes law.		
	2.2	Boundary conditions for static electric and magnetic fields		
	2.3	Faradays Law, Displacement current, Maxwells Equations: Integral and differential form for static and time varying fields and its interpretation		
3	Title	**Electromagnetic Wave Propagation**	1,2	9
	3.1	Wave equation: Derivation and its solution in Cartesian co-ordinates.		
	3.2	Solution of wave equations: Partially conducting media, perfect dielectrics and good conductors, Concept of Skin Depth.		
	3.3	Electromagnetic Power: Poynting Vector and power flow in free space and in dielectric, conducting media.		
	3.4	Polarization of wave: Linear, Circular and Elliptical.		

	3.5	Propagation in different media: Behavior of waves for normal and oblique incidence in dielectrics and conducting media.		
4	**Title**	**Waveguide**	1,2	6
	4.1	Wave propagation in parallel plane waveguide (No derivation expected), Analysis of waveguide general approach (No derivation expected), in waveguide.		
	4.2	Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation.		
5	**Title**	**Transmission Lines**	1,2	9
	5.1	Power frequency lines: Representation, losses and efficiency in power lines, effect of length, calculation of inductance and capacitance.		
		Radio frequency lines: Representation, propagation constant, attenuation constant, phase constant, group velocity, input impedance, characteristic impedance, trade-off between attenuation and power transfer, reflection coefficient, standing wave ratio, VSWR, ISWR, ABCD parameters of transmission line.		
	5.2	Smith Chart: Impedance locus diagram, impedance matching.		
6	**Title**	**Applications of Electromagnetics**	2,3	6
	Self-Study	Xerography. Laser printer, Faraday's cage, lightning, RF MEMS, Magnetic levitation, Metamaterials, RFID, Stealth aircraft, remote sensing, radio astronomy, EMI and Electromagnetic Compatibility, Different types of antennas.	1,2,6	06
Total				**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	**Basic operations on scalar and vectors** Working with Numbers: Scalars and Vectors using any simulation platform or Python. Working with Complex Numbers using any simulation platform or Python. Working with Matrices using any simulation platform or Python.
2	**Curl and Divergence** Numerical Computation of Divergence and Curl. Numerical Computation of Divergence and Curl for a Current Carrying Wire.

3	Write a program that displays the distribution of the electric potential due to an electric dipole with a moment located at the origin of a spherical coordinate system.
4	Numerical Integration and Calculating the Electric Field from a Ring of Charge.
5	3-D and 2-D radiation patterns of a Hertzian dipole using MATLAB/Python.
6	**Antenna parameters** Visualization of a wireless system with two antennas. Radiation patterns of a small loop antenna. Radiation patterns of a quarter-wave monopole.
7	**Waveguide:** Verify the relationship between wavelength of an EM wave in air and inside a rectangular waveguide.
8	Simulating the Two-ray Propagation Model in any simulation platform or Python.
9	**Using Virtual Lab: Introduction** to Smith chart and its application for the unknown impedance measurement using virtual lab IIT K
10	Measurement of Frequency and wavelength of a waveguide using Microwave bench setup.
11	**Using Virtual Lab: Study** of field pattern of various modes inside a rectangular waveguide using virtual lab IIT K
12	**Case Study-** The student is required to develop a simple tool to carry out unit conversions that are associated with EM-related calculations.

Text Books :

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Electromagnetic Waves	Third	R.K. Shevgaonkar	Tata McGraw Hill	2009
2	Principles of Electromagnetics	Sixth	Matthew N.O. Sadiku	Oxford International Student	2015

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Engineering Electromagnetics	Third	W.H. Hayt, and J.A. Buck	McGrawHill	2006
2	Electromagnetic Waves and Radiating Systems	Second	Edward C. Jordan and Keth G. Balmin	Pearson Publications	2006
3	Engineering Electromagnetics	Third	Nathan Ida	Springer Publications	2015
4	Antennas & Wave Propagation	Fourth	J.D. Kraus, R.J. Marhefka, and A.S. Khan	McGrawHill	2011

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Java Programming Lab	0	1	2	1	4	0	1	1	2
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
ET305		Theory	100*		--		--			100
		Laboratory	50		--		50#			100

Pre-requisite Course Codes, if any.	CS101: Problem Solving using Imperative Programming CS102: Problem Solving using OOPs
Course Objective: To learn Object-Oriented programming paradigm using Java programming language**.**	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET305.1	Demonstrate programming using basic constructs of JAVA.
ET305.2	Apply Inheritance and polymorphism for a given scenario.
ET305.3	Apply abstraction and exception handling to create an efficient program.
ET305.4	Use Generic classes and collection for solving problem.
ET305.5	Develop a mini project based on the real-world problem.

Note:

*= Tutorial-50 marks and Mini Project-50 marks (Preferably based on real-world problem statement from Industry/Academia/Research)

#= oral exam-20 marks and Lab experiment-30 marks

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET305.1	3				2							2
ET305.2	2				2							2
ET305.3	2				2							2
ET305.4	2				2							2
ET305.5	2	1	1	1	2	1			2	2		2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET305.1		2		2		
ET305.2		2		2		
ET305.3		2		2		
ET305.4		2		2		
ET305.5		2		2		

B. Tech. ETRX

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ·

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to JAVA**	1,2,3	3
	1.1	Fundamentals of Java Programming: Classes, JDK, JRE, JVM, Unicode system, I/O using Scanner class and Buffered Reader class.		
	1.2	Instance variables, Methods, Constructors.		
	1.3	Object class, Nested class, Access Specifiers, Abstract Classes and Wrapper Classes.		
2	Title	**OOP Concepts Mapping to JAVA**	1,2,3	4
	2.1	Inheritance (IS – A), Aggregation & Composition (Has – A) Method overloading & overriding, this, super, final keyword, Static.		
	2.2	Autoboxing and Unboxing, Polymorphism.		
	2.3	Packages and Interfaces: Package concept, creating user defined package, Access control protection, Interface.		
3	Title	**Exception Handling and Multithreading**	1,2,3	4
	3.1	Try and catch block, Multiple catch block, Nested try, finally block, Throw, Throws keywords, Exception propagation, Custom exception.		
	3.2	Create thread using Thread and Runnable class. Thread methods, schedule, sleep, join, Thread priority, Thread group, perform multiple tasks using multiple thread Thread synchronization.		
4	Title	**Generics and Collection**	1,2,3	3
	4.1	Creating Generic Classes, Generic Methods, Bounded Type		
	4.2	Collection's framework, methods of collection interface (Array list, Linked list, Queue etc.)		
			Total	**14**

Laboratory Component, if any.

Sr. No	Title of the Experiment
1	Program on I/O using command line arguments, scanner class, Buffered Reader etc.
2	Program on Constructor, types of constructors and constructor overloading.
3	Program on Polymorphism, Runtime polymorphism.
4	Program on Inheritance, Abstract Class, Interface.

5	Program on Nested Class, Aggregation, Composition.
6	Program on Multithreading.
7	Program on Exception Handling. (built in and User defined)
8	Program on Package and access modifiers.
9	Program on Generics
10	Program on Collection

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Java Programming From the Group Up	First	Ralph Bravaco, Shai Simoson	Tata McGraw-Hill	2009
2	Java The Complete Reference	Eleventh	Herbert Schildt	Tata McGraw-Hill	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	An introduction to Programming and Object Oriented Design using Java	Third	Jaime Nino, Frederick A. Hosch	Wiley Student Edition	2008
2	Java Programming A Practical Approach	First	C Xavier	Tata McGraw-Hill	2011
3	Java™ Programming Language	Fourth	Ken Arnold, James Gosling, David Holmes	The (Java Series) by Sun	2005

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

B. Tech. ETRX

Semester-VI

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Power Electronics	3	0	2	5	10	3	0	1	4
		Examination Scheme								
ET306		Component			ISE		MSE		ESE	Total
		Theory			75		75		150	300
		Laboratory			50		--		50	100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To impart knowledge on the basic topology, operation and analysis using performance parameters of power electronic converters.	
Course Outcomes (CO):*At the end of the course students will be able to*	
ET306.1	Understand the operation of power semiconductor switches.
ET306.2	Analyze various single and three phase AC-DC power converter circuits
ET306.3	Illustrate the operating principle and construct a various types of DC-DC converters.
ET306.4	Analyze various single and three phase DC-AC power converter circuits
ET306.5	Understand the operation of AC-AC voltage converters by means of circuit topology and waveforms.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET306.1	2.5											
ET306.2	2	3										
ET306.3		2										
ET306.4		2.5	2.5									
ET306.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PEO/PSO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET306.1	2	1				
ET306.2	2			2		
ET306.3	2			2		
ET306.4	2			2		
ET306.5						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

B. Tech. ETRX

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Power Semiconductor Devices**		
	1.1	Principle of operation, constructional features, characteristics of: SCR, GTO, MOSFET and IGBT, Si-Carbide-MOSFET and IGBT, Ga-Ni Power devices, Common type of Power Modules	T1, T3	**6**
	1.2	Basic Gate Drive circuits for SCR, MOSFET and IGBT		
2	**Title**	**AC to DC Converters**		
	2.1	Operation and analysis of single-phase controlled rectifiers with R, and RL load, freewheeling effect. Operation and analysis of three-phase controlled rectifiers with resistive load, effect of source inductance,	T1, T2, R4	**10**
	2.2	Single Phase and Three-Phase PWM Rectifier, Vienna Rectifier. Power factor improvements	T1, R4	
3	**Title**	**DC to DC Converters**		
	3.1	Switch Mode Power Converters, non-isolated and isolated converters, Buck, Boost and Buck-Boost converters, flyback and forward converters, Hardware design of SMPS converters and their Magnetics	T1, R4	**10**
	3.2	Closed loop control of Switched Mode DC-DC Converters with Constant Voltage and Constant Current mode of Operation	R5	
4	**Title**	**DC to AC Converters**		
	4.1	Principle of operation of Inverters, Inverter Classification.	T1,	
	4.2	Voltage source inverters: -Principle of operation and analysis of: Single phase Half bridge, full bridge, and three-phase bridge inverters, six step operation (R-Load), PWM control of Voltage source converters. Introduction to Space Vector Modulation	T2, R4	**10**
5	**Title**	**AC–AC converters**		
	5.1	Principle of on-off and phase control – single-phase half and full wave AC voltage controller, three-phase AC voltage controller. Single Phase Bidirectional AC switches using MOSFETs, IGBTs, Single-phase Bidirectional AC-AC converters	T2 R6	**6**
6	**Self Study**	Comparison of Power Semiconductor Devices, Detailed analysis of minimum one application for each type of converter (AC-DC, DC-AC, DC-DC)		**6***
			Total (*not included)	**42**

Laboratory Component (Indicative): To be completed minimum of 8 to 10 experiments

B. Tech. ETRX

Sr. No	Title of the Experiment
1	Study of Characteristics and Specification of SCR, MOSFET/ IGBT
2	Gate Driver Circuits for SCR, MOSFET, IGBTs
3	Single phase Line Commutated Semi-converter and Fully controlled Converter
4	Single phase PWM Vienna Rectifier
5	Operation and analysis of single- phase bridge inverter with R Load and controllable Switches
6	Demonstration of PWM three phase bridge Voltage Source inverter with L-C filter
7	Design and Demonstration of a Buck-Converter and Boost Converter in CCM
8	Design and Demonstration of a flyback-Converter
9	Design and Demonstration of single-phase AC Voltage Controller using Thyristors
10	Simulation Exercise on PWM Vienna Rectifier
11	Simulation Exercise on Single-phase PWM AC-AC converters with Bidirectional switches

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Power Electronics	Second	MD Singh and K.B Khanchandani	Tata McGraw Hill	2006

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Power Electronics and AC Drives	First	Bimal K Bose	Pearson Education Asia	2002
2	Modern Power Electronics	Second	P.C Sen	S.chand	2005
3	Power Electronics	Eleventh	P.S.Bimbra,	Khanna Publishers	2003
4	Power Electronics	First	S. K. Mandal	McGraw Hill Education (India)	2014
5	Switch-mode power converters	First	Keng C. Wu.	Elsevier Inc.	2006,
6	Advanced Power Electronics Converters	First	EUZELI CIPRIANO DOS SANTOS JR., EDISON ROBERTO CABRAL DA SILVA	John Wiley & Sons	2015

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Computer Communication Networks	3	-	2	5	10	3	-	1	4
ET307		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC301: Analog and Digital Communication
Course Objective: The objective of the course is to provide a fundamental understanding of Computer Communication networks.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET307.1	Apply Conceptual understanding and functional aspects of computer communication and telecom networks.
ET307.2	Analyze design and configure small and medium sized computer network that meets a specific need for communications.
ET307.3	Simulate computer networks and analyze the simulation results including troubleshoot connectivity problem occurring at layers of TCP/IP model.
ET307.4	Apply the principles behind the Modern Network approaches such as SDN NFV and IoT and security issues.

CO-PO Correlation Matrix: (1-Weak, 2-Medium, 3-Strong)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET307.1	3	3										
ET307.2			3	2	3							2
ET307.3			3		3	2						
ET307.4	2	2							3	3		3

CO-PEO/PSO Correlation Matrix : (1-Weak, 2-Medium 3-Strong)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET307.1	1			2		
ET307.2						
ET307.3				3		
ET307.4	1				2	

B. Tech. ETRX

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember · √	Understand · √	Apply √ ·	Analyze · √	Evaluate √	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Fundamental of Computer Networks**	1	08
	1.1	Basic definitions. Networking devices. Layering architecture: The OSI model. Description of layers.		
	1.2	The Internet protocols TCP/IP protocol suit, IP Protocol and address. What is the Internet? Delay in the Internet (trace route and ping). History of the Internet. Security in the Internet.		
2	**Title**	**Enterprise Network Design**	2	06
	2.1	Network requirements, Planning and Design, Structured Wiring and Structured Network Design consist of Core Layer, Distribution Layer, and Access.		
	2.2	Network Design methodology &Network Design considerations Core Layer Technologies. Investigating Server Farms and Security Integrating, Remote Sites into the Network Design.		
3	**Title**	**Transport and Application Layer**	1,3	06
	3.1	Transport Protocols introduction. Reliable data transfer - Stop-and-wait and Go-back-N design and evaluation. TCP and UDP semantics and syntax. TCP RTT estimation. Principles of congestion control - efficiency and fairness, reactive and proactive. Socket's programming A simple client-server implementation.		
	3.2	Application layer: Application layer protocols, Client-server as a key model. Web, HTTP, FTP, SMTP, POP3, and DNS. Peer-to-peer file sharing networks.		
4	**Title**	**Software Defined Network and Network Function Visualization**	5	10
	4.1	Network Requirements - The SDN Approach - SDN- and NFV-Related Standards - SDN Data Plane - OpenFlow Logical Network Device -		

		OpenFlow Protocol - SDN Control Plane Architecture - REST API - SDN Application Plane Architecture.		
	4.2	NFV Concepts - NFV Reference Architecture - NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use Cases - SDN and NFV		
5	**Title**	**Internet of Things (IoT) SECURITY**	1,3	10
	5.1	Threats and attacks. Symmetric and public key cryptography. IPsec-Authentication Header-Encapsulating security payload,		
	5.2	Secure sockets-Secure Socket Layer (SSL) - Firewalls and Internet access- Packet filter firewall- Proxy firewall- VPNs – Mobile IP – Header Compression – Voice over IP –		
	Title	**Networks**		5
6	Self-Study	Types of Networks, Transmission media, Network Topologies		
Total				**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Network Lab set up
2	IP Networking & Network Commands: ifconfig, ping, traceroute, netstat, arp ,nslookup dig & route etc.
3	Network Protocol Analyzers: TCPDUMP & Wireshark
4	Installation & Configuration of Web Server (at least four) using open-source tool
5	Network Socket Programming
6	Installation and configuration of open-source Network simulator software
7	Firewall Implementation (IPTABLES)
8	Implementation of SDN
9	Implementation of VPN
10	Cryptography using open source tools/Crypt tools and open SSL

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	TCP/IP protocol suit	Fourth	Behrouz A. Forouzan (Author)	McGraw Hill Education	2009
2	Introducing Network Design Concepts	-	CCNA Discovery Learning Guide	-	-

3	Computer Networking: A Top-Down Approach	Fifth	J. F. Kurose and K. W. Ross	Prentice Hall	2009
4	Data Communication and Networking	Fourth	B.A.Forouzan	McGraw Hill	2017
5	Information Security: Principles and Practice	First	Deven Shah	Wiley	2007

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud	--	William Stallings	Addison-Wesley ISBN: 9780134175393	2015
2	Computer Networks	Fifth	A.Tanenbaum	Pearson Education	2013
3	Data and Computer Communications	Tenth	William Stallings	Pearson Education	2013

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Digital CMOS VLSI Design	3	--	--	5	8	3	--	--	3
		Examination Scheme								
ET311		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	--		--		--		--	

Pre-requisite Course Codes, if any.	ET101: Basic Electrical Engineering EC101: Digital Systems and Microprocessors ET202: Electronic Devices ET205: Analog Circuits
Course Objective: Today's growth in electronic sector is due to improvements in semiconductor chip design. VLSI course is the foundation course introduced to teach fundamentals of MOSFET based logic circuit design. The primary objective of this course is to impart basic knowledge required to study advanced courses in VLSI domain.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
ET311.1	Discuss scaling theory for MOSFET
ET311.2	Design MOSFET based inverter circuits with given constraints
ET311.3	Analyze MOSFET based combinational and sequential logic circuits
ET311.4	Realize MOSFET based logic circuits with different design styles
ET311.5	Discuss principle of working of semiconductor memories

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

ET311	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET311.1	3											
ET311.2		3										
ET311.3			3									
ET311.4			3									
ET311.5			3									

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

ET311	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET311.1	1	2	2			
ET311.2	2	1	2		2	2
ET311.3	1	1	1		2	

ET311.4	2	2	2		2	
ET311.5	1	2	1		2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember · √	**Understand · √**	**Apply √ ·**	**Analyze · √**	**Evaluate**	**Create**

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Review of MOSFET Physics**		**08**
	1.1	Threshold Voltage Equation, MOSFET Structure and Operation, Current-Voltage Characteristics and MOSFET Capacitances	1	
	1.2	MOSFET Scaling, Types of scaling and Small geometry effects	1	
2	**Title**	**MOSFET Inverters**		**08**
	2.1	Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters	1	
	2.2	Dynamic Characteristics of inverters, design of CMOS inverters with constraints	1	
3	**Title**	**Combinational MOS Logic Circuits**	1,2	**08**
	3.1	MOS Logic Circuits with Depletion NMOS Loads and CMOS Logic Circuits		
	3.2	Complex Logic Circuits and Concept of equivalent CMOS inverter		
4	**Title**	**Dynamic Logic Circuits**	1	**08**
	4.1	Static CMOS, pass transistor logic, transmission gate		
	4.2	Pseudo NMOS, Domino, NORA, Zipper, C^2MOS		
5	**Title**	**Sequential MOS Logic Circuits**	1,2	**06**
	5.1	Behavior of Bi-stable Elements		
	5.2	**Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, decoder		
6	**Title**	**Semiconductor Memories**	2,3	**06**
	6.1	ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits),		
	6.2	DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits),		
	6.3	Flash (mechanism, NOR flash, NAND flash)		

	6.4	**Peripheral Circuits:** Sense amplifier, decoder		
			Total	**42**

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	CMOS Digital Integrated Circuits Analysis and Design	Third Edition	Sung-Mo Kang, Yusuf Leblebici	Tata McGraw Hill	
2	Digital Integrated Circuits: A Design Perspective	Second Edition	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson Education	
3	Introduction to VLSI Circuits and Systems	Student Edition	John P. Uyemura	Wiley	2013

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Embedded Systems	3	--	--	5	8	3	--	--	3
		Examination Scheme								
ET312		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	EC101: Digital Systems and Microprocessors ET201: Computer Architecture and Organization ET206: Microcontrollers
Course Objective: To empower the students in system design skills using modeling practices and learn key concepts in reliability of embedded systems with respect to Industrial standards.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
ET312.1	Discuss design metrics of embedded system to design real time applications to match recent trends in technology.
ET312.2	Analyze the reliability of embedded system with respect to fault detection and fault tolerance
ET312.3	Apply the industry standards for assessment of embedded product
ET312.4	Analyze the given embedded application with respect to security
ET312.5	Choose suitable criteria for selection of embedded application.
ET312.6	Demonstrate hardware and software skills based on embedded case studies.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									
CO2	2	2	2									
CO3	2	2	2									
CO4	2	2	2									
CO5	2	2	2									
CO6	2	2	2	2	2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
CO1		1				
CO2	1		1			

CO3	1		1			
CO4	1	1	1			
CO5		1	1			
CO6	1		1	2		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	**Understand ·**	**Apply ·**	**Analyze ·**	**Evaluate**	**Create**

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Fundamentals of Embedded System**		**12**
	1.1	Introduction to Embedded Systems, Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Design trade-offs due to process compatibility, thermal considerations, etc. Real time System's requirements, real time issues, interrupt latency	1,2	
	1.2	Embedded Product development lifecycle. Program Modeling concepts with design examples: DFG, FSM, Petri-net, UML, Use case, Object and Class Structuring	1,2	
	1.3	Technological aspects of embedded systems: Embedded microcontroller cores, embedded memories, interfacing between analog and digital blocks, signal conditioning, digital signal processing, sub system interfacing, interfacing with external systems and user interfacing. Introduction to real time programming languages and operating systems for embedded systems.	1,5	
2	**Title**	**Reliable Embedded System**		**08**
	2.1	Reliable Embedded System: Single-program, real-time embedded systems, TT vs. ET architectures, Modeling system timing characteristics, basic tick lists, determining the required tick interval, short tasks, importance of task offsets, task sequence initialization, task jitter, response times, importance of WCET/BCET information, challenges with WCET/BCET measurements, TTC scheduler, Fault-tolerance Techniques	3	
3	**Title**	**Industry Standards**		**06**
	3.1	Introduction to IEC 61508 standard: Organizing and managing the life-cycle, Requirements involving the specification, Requirements for design and development, Integration and test,	6,7	

		Operations and maintenance, Validation, Modifications, Acquired sub-systems, Organizing and managing the software engineering		
	3.2	Introduction to IEC 60601 standard: Protection of radio services, Protection of the Public Mains network, Immunity, Electrostatic Discharge, Radiated RF electromagnetic fields, Electrical fast transients and bursts.	8	
	3.3	Introduction to IEC 26262 : Introduction of ISO/DIS 26262 (ISO 26262), Parts of ISO 26262, ASIL Levels, Product Development System Level, Product Development Software Level, Fitting software tools into ISO 26262 process	9	
4	**Title**	**Security in Network Embedded System**		**08**
	4.1	Networked Embedded System: Network Fundamentals, Layers and Protocols. Network Architectures, Network Components-Bridges, Routers, Switches, Distributed Embedded Architectures, Elements of Protocol Design, High Level Protocol Design Languages, Network Based Design, Internet-Enabled Systems: Protocols for industrial and control applications, Internet working Protocols. Wireless Applications: Blue-tooth	10	
	4.2	Security in Embedded Devices and Systems: Introduction to secure embedded systems, The Key, Using Keys, Various protocols, attacks on embedded systems and counter measures.	4	
5	**Title**	**Case Studies ***		**08**
	5.1	**Embedded Control Applications:** Introduction, Open-loop and Closed Loop Control Systems Examples: Speed Control. PID Controllers: Software Coding of a PID Controller, PID tuning. Fuzzy Logic Controller Application Examples: Washing Machine, Auto-focusing digital camera and Air-conditioner	1,2	
	5.2	**Automotive Embedded Systems**: Automotive Architectures, embedded communication, embedded software and development processes, Verification, Testing and Timing Analysis	1,2	
	5.3	Embedded systems in Healthcare domain.	1,2	
			Total	**42**

*** Students are supposed to do some experiments/mini-projects as per instructions of teacher and requires individual efforts of students**

B. Tech. ETRX

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Embedded System: Architecture, Programming and Design	2nd edition	Rajkamal	Tata McGraw-Hill	2011
2	Introduction to Embedded Systems	2nd edition	Shibu K. V	Tata McGraw-Hill	2017
3	The Engineering of Reliable systems: LPC1769	-	Pont M. J	SafeTTy Systems	2014
4	Security in Embedded Devices	2010th edition	Gebotys, Catherine H.	Springer	2010
5	Embedded Microcomputer Systems: Real time Interfacing	3rd edition	Jonathan W. Valvano	Cengage Learning	2012
6	Functional Safety, A Straightforward Guide to applying IEC 61508 and Related Standards	2nd edition	David Smith	Elsevier	2004
7	IEC 61508: IEC standard for the functional safety for electrical, electronics and programmable electronics equipment	-	-	https://www.iec.ch/safety	-
8	IEC 60601: IEC standard on Medical Electric Equipment	-	-	https://www.iec.ch/safety	-
9	IEC 26262: IEC standard on Road vehicles	-	-	https://www.iec.ch/safety	
10	Embedded Systems Handbook: Networked Embedded Systems	2nd edition	Richard Zurawski	CRC Press	2009

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Speech and Audio Processing	2	0	2	8	8	2	0	1	3
ET321		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To familiarize the basic & advance mechanisms of speech and audio processing	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET321.1	Apply concepts of speech coding.
ET321.2	Analyze Audio Perception& psycho-acoustic model.
ET321.3	Demonstrate parametric representation, time domain & frequency domain representation of speech.
ET321.4	Analysis of predictive methods of speech.
ET321.5	Develop systems for various applications of speech & audio processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET321.1	2											
ET321.2		2										
ET321.3			2									
ET321.4			2		2							
ET321.5					2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

ET321	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET321.1	2				2		
ET321.2	2				2		
ET321.3		2				2	
ET321.4		2				2	
ET321.5		2				2	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

B. Tech. ETRX

Remember	Understand	Apply ·	Analyze ·	Evaluate ·	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Mechanics of speech**		8
	1.1	Speech production: Mechanism of speech production, Acoustic phonetics – Digital models for speech signals -Sampling speech signals, basics of quantization, delta modulation, and Differential PCM	1,2	
	1.2	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	1,2	
2	Title	**Time domain methods for speech processing**		8
	2.1	Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, zero crossing Rate – Silence Discrimination using ZCR and energy	1,2	
	2.2	Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.	4	
3	Title	**Frequency domain method for speech processing**	1,2	8
	3.1	Short Time Fourier analysis: Fourier transform and linear filtering interpretations.	4	
	3.2	Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder.	2,3	
	3.3	Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders, Speech coding, speech enhancement.	3,5	
4	Title	**Linear predictive analysis, synthesis of speech**	3,5	4
	4.1	Basic Principles of linear predictive analysis – Auto correlation method – Covariance method.		
	4.2	Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm.		
	4.3	Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP, Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis – VOIP.		
5	Self Study	Audio compression methods, Audio quality analysis, Spatial Audio Perception and rendering, Speaker identification and verification		
			Total	**28**

B. Tech. ETRX

Laboratory Component

Sr No.	Experiment Title
1	Speech production
2	Analysis of speech signal
3	Short-time spectrum analysis of speech
4	Spectrographic analysis of speech
5	Linear prediction analysis of speech
6	Formant synthesis
7	Cepstral analysis of speech
8	Analysis by synthesis of speech
9	Manual speech signal-to-symbol transformation
10	Speaker Analysis /speaker recognition

Text Books :

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Communications: Human & Machine	Second	Douglas O'Shaughnessy	IEEE Press, Hardcover 2/e, ISBN: 0780334493.	1999
2	Discrete-Time Speech Signal Processing	First	Thomas F, Quatieri,	Prentice Hall /Pearson Education	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Processing and Synthesis Toolboxes	First	Donald G. Childers	John Wiley &Sons,September ISBN:0471349593	1999
2	Fundamentals of Speech Recognition	First	L.R. Rabiner and B. H. Juang	Prentice Hall	2009
3	Speech and Audio Signal Processing	Second	Ben Gold and Nelson Morgan	John Wiley and Sons Inc., Singapore	2011
4	Discrete Time Processing of Speech Signals	First	J.R. Deller, J.H.L. Hansen and J.G. Proakis	John Wiley, IEEE Press	1999
5	Digital Processing of Speech Signals	First	L.R.Rabiner and R.W.Schaffer .	Prentice Hall	1979

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	DSP Processors	2	0	2	4	4	2	0	1	3
		Examination Scheme								
ET322		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To develop implementation of DSP algorithms using DSP Processor	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET322.1	Evaluate different types of errors in DSP implementation.
ET322.2	Describe architectures of TMS320XX devices.
ET322.3	Explore various interfacing devices to DSP Processors.
ET322.4	Demonstrate Fast DSP algorithms using DSP processor
ET322.5	Develop DSP application using DSP hardware.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET322.1	2											
ET322.2		2	1									
ET322.3		2	1									
ET322.4	2				1							
ET322.5			2					1	1	1		1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
ET322.1		2		2		
ET322.2		2		2		
ET322.3		2		2		
ET322.4		2		2		
ET322.5		2		2		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

Theory Component

B. Tech. ETRX

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Computational Accuracy in DSP Implementations**		04
	1.1	Number formats for signals and coefficients in DSP systems. Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.	1,2	
	1.2	Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors.	1,2	
2	Title	**Programmable DSP Hardware**		08
	2.1	Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT).	1,2	
	2.2	IEEE standard for Fixed- and Floating-Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.	1,2	
3	Title	**Structural and Architectural Considerations**		06
	3.1	Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point &floating-Point TI DSP Processors.	1,2	
	3.2	Data Addressing modes, Memory space of Processors, Program Control, instructions, and programming of TMS320XX Processors.	1,2	
	3.3	On-Chip Peripherals, Interrupts of TMS320XX processors, Pipeline operation of TMS320XX Processors.	1,2	
4	Title	**VLIW Architecture**		06
	4.1	Current DSP Architectures, GPUs as an alternative to DSP Processors.	1,2	
	4.2	Code Composer Studio, Mixed C and Assembly Language programming, on-chip peripherals, Simple applications developments as an embedded environment.	1,2	
	4.3	Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).	1,2	
5	Title	**Hardware implementation of DSP Algorithms**		04
	5.1	The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters	1,2	
	5.2	An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation	1,2	
6	Self-Study	A CODEC interface circuit, A CODEC-DSP interface example.		
			Total	**28**

B. Tech. ETRX

Laboratory Component

Sr. No	Title of the Experiment
1	Harmonic Generation
2	FIR Filtering
3	IIR Filtering
4	Fast Fourier Transform Algorithm
5	Linear Filtering Algorithm
6	Sensor Interface
7	ADC-DAC Interface
8	Real Time Audio Signal Processing
9	Real time Biomedical Signal Processing
10	Real Time Power Signal Processing

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processors, Architecture, Programming and Applications.	First	B. Venkata Ramani and M. Bhaskar	Tata McGraw Hill (TMH) Publication 2004	2004
2	DSP Implementation using DSP microprocessor with Examples from TMS32C54XX	First	Avtar Singh, S.Srinivasan	Thomson Publication	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	DSP Processor Fundamentals, Architectures & Features	First	Phil Lapsley, Jeff Bier, AmitShoham, Edward A. Lee	Wiley Publication	1997
2	Digital Signal Processors Architectures, Implementation and Application	First	Sen M. Kuo&WoonSergGan,	Pearson	2009
3	Architectures for Digital Signal Processing	First	Peter Pirsch,	Wiley Publication	1998
4	Digital Signal Processing	Second	S. Salivahanan A. Vallavaraj G. Gnanapriya	Tata McGraw Hill Publication	2001

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Power Electronic Converters (@)	2	0	2	5	10	3	0	1	3
		Examination Scheme								
		Component			ISE		MSE		ESE	Total
ET331		Theory			50		50		100	200
		Laboratory			50		--		50	100

@--> Not to be repeated if already studied as a Program Core i.e. Power Electronics

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To impart knowledge on the basic topology, operation and analysis using performance parameters of power electronic converters.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
ET331.1	Understand the operation of power semiconductor switches.
ET331.2	Analyze various single and three phase AC-DC power converter circuits
ET331.3	Illustrate the operating principle and construct a various types of DC-DC converters.
ET331.4	Analyze various single and three phase DC-AC power converter circuits
ET331.5	Understand the operation of AC-AC voltage converters by means of circuit topology and waveforms.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET331.1	2.5											
ET331.2	2	3										
ET331.3		2										
ET331.4		2.5	2.5									
ET331.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET331.1	2	1					
ET331.2	2				2		
ET331.3	2				2		
ET331.4	2				2		
ET331.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create

B. Tech. ETRX

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Power Semiconductor Devices**		
	1.1	Principle of operation, constructional features, characteristics of: SCR, GTO, MOSFET and IGBT, Si-Carbide-MOSFET and IGBT, Ga-Ni Power devices, Common type of Power Modules	T1, T3	8
	1.2	Basic Gate Drive circuits for SCR, MOSFET and IGBT		
2	Title	**AC to DC Converters**		
	2.1	Operation and analysis of single-phase controlled rectifiers with R, and RL load, freewheeling effect. Operation and analysis of three-phase controlled rectifiers with resistive load, effect of source inductance,	T1, T2, R4	10
	2.2	Single Phase and Three-Phase PWM Rectifier, Vienna Rectifier. Power factor improvements	T1, R4	
3	Title	**DC to DC Converters**		
	3.1	Switch Mode Power Converters, non-isolated and isolated converters, Buck, Boost and Buck-Boost converters, flyback and forward converters, Hardware design of SMPS converters and their Magnetics	T1, R4	8
	3.2	Closed loop control of Switched Mode DC-DC Converters with Constant Voltage and Constant Current mode of Operation	R5	
4	Title	**DC to AC Converters**		
	4.1	Principle of operation of Inverters, Inverter Classification.	T1,	
	4.2	Voltage source inverters: -Principle of operation and analysis of: Single phase Half bridge, full bridge, and three-phase bridge inverters, six step operation (R-Load), PWM control of Voltage source converters. Introduction to Space Vector Modulation	T2, R4	10
5	Title	**AC–AC converters**		
	5.1	Principle of on-off and phase control – single-phase half and full wave AC voltage controller, three-phase AC voltage controller. Single Phase Bidirectional AC switches using MOSFETs, IGBTs, Single-phase Bidirectional AC-AC converters	T2 R6	6
6	Self Study	Exercise on minimum of 4 to 6 Simulations		6*
			Total (*not included)	**42**

B. Tech. ETRX

In-Semester Evaluation (Indicative): To be completed minimum of 4 to 6 Simulations

Sr. No	Title
1	**Simulation Exercise on Single phase Line Commutated Semi-converter and Fully controlled Converter**
2	**Simulation Exercise on Single phase PWM Vienna Rectifier**
3	**Simulation Exercise on Single- phase bridge inverter with R Load and controllable Switches**
4	**Simulation Exercise on PWM three phase bridge Voltage Source inverter with L-C filter**
5	**Simulation Exercise on Buck-Converter and Boost Converter in CCM**
6	**Simulation Exercise on Fly-back-Converter**
7	**Simulation Exercise on Single-phase AC Voltage Controller using Thyristors**
8	**Simulation Exercise on PWM Vienna Rectifier**
9	**Simulation Exercise on Single-phase PWM AC-AC converters with Bidirectional switches**

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Power Electronics	Second	MD Singh and K.B Khanchandani	Tata McGraw Hill	2006

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Power Electronics and AC Drives	First	Bimal K Bose	Pearson Education Asia	2002
2	Modern Power Electronics	Second	P.C Sen	S.chand	2005
3	Power Electronics	Eleventh	P.S.Bimbra,	Khanna Publishers	2003
4	Power Electronics	First	S. K. Mandal	McGraw Hill Education (India)	2014
5	Switch-mode power converters	First	Keng C. Wu.	Elsevier Inc.	2006,
6	Advanced Power Electronics Converters	First	EUZELI CIPRIANO DOS SANTOS JR., EDISON ROBERTO CABRAL DA SILVA	John Wiley & Sons	2015

B. Tech. ETRX

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Embedded System Design for Power Converter Applications	3	0	0	5	10	3	0	0	3
		Examination Scheme								
		Component			ISE		MSE		ESE	Total
ET332		Theory			50		50		100	200
		Laboratory			50		--		50	100

Course content

Digital Signal Controller (DSC: A micro-controller with a DSP engine): Architecture and real-time programming in Assembly and Embedded C. Introduction to Fixed Point Arithmetic. Understanding the constraints of program memory and execution time. Programming peripherals including GPIO, TIMERS etc. On Chip FLASH and EEPROM programming.

Field Programmable Gate Array (FPGA): Architecture and programming of digital circuits including Finite State Machines (FSM) in Verilog HDL. Understanding the CAD tool and various timing issues.

Communication-Chip level: AXI, Board level: SPI, I2C, System level: RS 232, CAN, MODBUS RTU on RS 485. Developing a GUI for supervisory control and monitoring. Introduction to different semiconductor memories: RAM, ROM, NVRAM etc. and their applications.

Analog sensing: Anti-aliasing filter design, scaling, online calibration and biasing. Continuous time feedback controller design and its discrete time implementation, D/A and A/D converters, effects of sampling, modeling the Pulse Width Modulator (PWM) etc.

Co-design: How to optimally implement an embedded task using a programmable processor (DSC) and a re-configurable hardware (FPGA). Embedded design of a typical Power Conversion System including: process control, protection, monitoring, real-time feedback control etc.

Concept of Hardware-in-the loop simulation in Power converters, Case-study: Design of Embedded system controller for (a) Induction Heating System (b) Three Phase Active Rectifier for PF Correction

Prerequisites

Under graduate level analog electronics, digital electronics and classical feedback control theory. Familiarity with micro-processor, digital signal processing and previous experience in programming will be helpful but not a necessity.

References

(1) Fundamentals of Digital logic with Verilog Design, S Brown and Z Vranesic, McGraw Hill Education; 2nd edition (2017).

(2) PIC Micro-controllers and Embedded Systems, Using assembly and C for PIC 18 Mazidi, Mckinlay and Causey, Pearson Education India; 1st edition (2008)

(3) Feedback Control of Dynamic Systems, GF Franklin, JD Powell and Naeini, Pearson (2008)

(4) Microelectronic Circuits: Theory and Applications, AS Sedra and K Smith, Oxford University Press (2017)

(5) Digital Signal Processing, JG Proakis and DK Manolakis, Pearson Education India; 4th edition (2007)

(6) Digital Control of HighFrequency SwitchedMode Power Converters, (IEEE Press Series on Power Engineering) Lucca Corradini, Dragan Maksimovi, Paolo Mattavelli, Regan Zane, Wiley-Blackwell (2015)

(7)A Practical Introduction to Hardware/Software Co-design, Patrick R. Schaumont Springer; 2nd edition (2014).